

## 8.—UPPER EOCENE FORAMINIFERA FROM DEEP BORINGS IN KING'S PARK, PERTH, WESTERN AUSTRALIA.

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Communicated by PROFESSOR E. deC. CLARKE.

### INTRODUCTION.

During the course of boring operations for artesian water in King's Park, Perth, in 1930 and 1931, a number of samples of the rocks met with were obtained. These were examined by Mr. S. E. Terrill, of the Geology Department of the University of Western Australia, who recognised the presence of foraminifera. In July, 1931, Miss Lucy Hosking, B.A., now Mrs. N. J. Hanrahan, also of the Geology Department, forwarded a number of the samples to the writer with the request that they be examined with a view to seeing whether the foraminifera could be used for the purpose of zoning the coastal plain beds. Notes on the species identified were shortly afterwards supplied to Miss Hosking.

In October, 1933, Professor E. deC. Clarke sent a further set of samples from a second boring which had been put down in King's Park, with a note that they probably contained some foraminifera which might be suggestive of the age of the beds.

These samples were also examined, but the assemblage of foraminifera appeared to contain Cretaceous and Tertiary elements and the published work at the time did not then permit of a satisfactory determination of the age of the beds. In 1935, Chapman and Crespin (1935 a, p. 126), on information furnished by the writer, placed the lignitiferous shale occurring at 780 feet in the first bore in the Lower Oligocene and stated that the beds above the shale were possibly Upper Oligocene.

During the last two or three years, several papers have been published in America by Dr. J. A. Cushman, either alone or in collaboration with others, on Eocene faunas from the United States, which bear a striking resemblance to that found in the King's Park bores. These have enabled the age of the King's Park foraminifera to be determined as Upper Eocene. The evidence for this is given in the following paper.

The only previous record of Eocene marine beds from Australia is that of Chapman and Crespin (1935, pp. 55-62) from the North-West Division of Western Australia. The age of these, determined upon the larger foraminifera, of the genera *Discocyclina* and *Pellatispira*, was given as Middle to Upper Eocene. The finding of a faunule of smaller foraminifera of Eocene age in the vicinity of Perth is, therefore, of much interest, and the writer is deeply indebted to Professor Clarke and his staff for the opportunity of examining and describing it. Professor Clarke has also kindly furnished references to the published literature in relation to the rocks underlying Perth.

My best thanks are also due to the Commonwealth Palaeontologist, Miss Irene Crespin, B.A., for suggesting an Eocene age for the beds, and to my friend and collaborator, Mr. Frederick Chapman, the first Commonwealth Palaeontologist, for his assistance in many ways.

#### NOTES ON THE SAMPLES.

Little is published or known concerning the rocks underlying Perth. The fullest information is given by Forman (1933, pp. 44, 45) in his "Final Report on the Correlation of the Artesian Bores of the Metropolitan Area." Forman states:—

"The base of the coastal limestone series, consisting of current bedded calcareous sandstones, lies at elevations varying from sea-level to as much as 180 feet below sea-level in different parts of the Metropolitan Area.

"Underlying the coastal limestone series there are lacustrine deposits of calcareous shales and sandstones passing downwards into a series of marine beds of calcareous shales or mudstones, sandstones and impure limestones. All of the beds are extremely lenticular.

"Under the Metropolitan Area there are three distinct artesian water-bearing horizons. These horizons can be distinguished by water analyses, static heads and temperatures of the various flows. The horizons when contoured from bore to bore are found to be unconformable and it is suggested that the water-bearing horizons lie on the surface of the unconformities, because of the frequent occurrence of extremely coarse sands and small boulders in the water bearing zones. These sands are in distinct contrast to the fine-grained nature of the sediments throughout the series.

"Of the three horizons, the upper two have a limited distribution. The upper horizon is met with in the bores in the vicinity of the city and at Osborne Park, and it is thought that the bores in the Guildford District also draw their water from this horizon. The second horizon is met with in the bores in the Leederville District and in the King's Park bores on Mount's Bay Road. The third horizon covers a larger area, having been encountered in all bores of sufficient depth."

The samples\* examined by the writer are from depths between 120 feet and 780 feet in King's Park Bore No. 1, and between 230 feet and 1,950

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\*In connection with the depths assigned to these samples it should be noted that a percussion plant was used, casing being kept within a few feet of the bottom. Although some mixing of material must take place under these conditions, experienced drillers say that the range of contamination is not more than 50 feet. Samples of the "country" were taken at every noticeable change in the rocks, or, if the rocks did not change, at every 20 feet, and consisted of the contents of the first haul of the sand pump from that depth. Actually, however, the samples sent for palaeontological examination were all obtained by scraping the bit when it was raised preliminary to sand-pumping. The drillers consider that these are undoubtedly true samples for the depths quoted.

It may be added that, as the beds from which the foraminifera were obtained are clearly all of the same age and, with the exception of the sample from 780 ft. in Bore No. 1, show similar conditions of sedimentation, the effect of possible contamination of samples is here relatively unimportant. It has, however, been looked for, as differences in the mode of preservation of the foraminifera in the various samples have usually facilitated the detection of any admixture of specimens from a higher level.



feet in King's Park Bore No. 2. The foraminifera occur in all of the samples from the first bore, but in the second bore are confined to those above 780 feet, at which depth a dark grey unfossiliferous shale occurs. This, Professor Clarke informs me, is the cover bed of the upper artesian water horizon (i.e., Forman's second horizon, W.J.P.). Between 780 and 1950 feet, the samples are unfossiliferous and apparently represent deposits of fresh water origin. Particulars of these are as follows:—

1030 feet: Sandstone with shale bands. Professor Clarke states that the bailer also brought up granite pebbles and boulders, apparently underlying this bed.

1210 feet: Brownish-grey loosely consolidated sand. The sand grains measure up to 4mm. in diameter and are sub-angular to rounded in outline.

1558 feet: Dark-grey pyritous sandy clay, the sand grains being generally sub-angular.

1772 feet: Clay of similar character to that from 1558 feet. This immediately overlies the second water horizon.

1950 feet: Fine-grained compact grey shale.

While fossiliferous beds do not occur in the King's Park bores below 780 feet, Miss Crespín has informed me that, in samples she has recently examined from the Perth area, she has also met with Lower Cretaceous foraminifera. These occur in the Zoological Gardens Bore below 1680 feet down to 1750 feet, and in the Leederville Valley Bore at 1650 feet down to 1746 feet. Above these, strata with foraminifera similar to those in the King's Park Bores are present.

With the exception of the sample from 780 feet in Bore No. 1, which is a lignitiferous shale with *Cyclammina* as the only fossil, all of the fossiliferous material is of the same character. It is a light fawn-grey calcareous soft shale, which is intercalated between sandstone beds in the bores. After washing, the residues consist of foraminifera, nearly all of which are very small, broken sponge spicules, ostracods, a few bryozoa and radiolaria, and occasional poorly-preserved molluscs. There is also a large percentage of sand grains, mostly sub-angular, and some glauconite.

Mr. Leo. W. Stach, B.Sc., has kindly examined the bryozoa and his identifications are as follows:—

*Crisia acropora* Busk

*Mesostomaria angustiloba* (Busk)

*Costaticella benecostata* (Levinsen)

*Idmonea* sp.

*Entalophora* sp.

Mr. Stach states the three species identified have a known range from Janjukian (? Upper Oligocene) to the present time.

Of the sponges, the best-represented is the genus *Geodia*, the white reniform spicules of which are conspicuous in every sample. There are several examples of annulated spicules from 430 feet in Bore No. 2. These have been identified by Mr. F. Chapman as *Geodites* sp., a genus confined to Cretaceous and Eocene beds.

Sixty-nine species of foraminifera are here recorded from the bores. This does not represent all of the species present as a number, which are rare or represented by poorly preserved specimens, have been omitted.

The types have been deposited in the collection of the Geology Department of the University of Western Australia.





32.	<i>Bulinella westraliensis</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	c
33.	<i>Robertina</i> sp. ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
34.	<i>Angulogerina subangularis</i>	...	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	c
35.	<i>Cassidulina</i> sp. ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	f
36.	<i>Bolivinopsis crespinae</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	r
37.	<i>B. eocenica</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	r
38.	<i>Gümbelina venezuelana</i> , var. <i>rugosa</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	r
39.	<i>Patellina</i> sp. aff. <i>corrugata</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
40.	<i>Discorbis assulatus</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	f
41.	<i>Heronallenia pusilla</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	r
42.	<i>Valvulineria sculpturata</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	r
43.	<i>Ceratobulimina westraliensis</i>	...	c	...	...	...	...	...	...	...	...	...	...	...	...	...	...	c
44.	<i>Gyroidina soldanii</i> ...	...	c	...	...	...	...	...	...	...	...	...	...	...	...	...	...	f
45.	<i>G. soldanii</i> , var. <i>octocamerata</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
46.	<i>Pulvinulinella obtusa</i> , var. <i>westraliensis</i>	...	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	c
47.	<i>Epistomina elegans</i> ...	f	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	r
48.	<i>Siphonina</i> sp. ...	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
49.	<i>Anomalina perthenensis</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	f
50.	<i>A. westraliensis</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	c
51.	<i>Cibicides lobatulus</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
52.	<i>C. pseudocoarvus</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	do.
53.	<i>C. pseudoungerianus</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	do.
54.	<i>C. umbonifer</i> ...	...	f	...	...	...	...	...	...	...	...	...	...	...	...	...	...	do.
55.	<i>Pullenia quinqueloba</i>	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Olig.-Recent
56.	<i>Globigerina triloba</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Eocene-Recent
57.	<i>G. inflata</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	U. Eocene Mexico
58.	<i>G. orbiformis</i> ...	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	L. Olig. N.Z.
59.	<i>Globorotalia chapmani</i>	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Eocene-Recent
60.	<i>Nonion novozelandicus</i>	...	c	r	...	...	...	...	...	...	...	...	...	...	...	...	...	do.
61.	<i>Anmodiscus</i> aff. <i>incertus</i>	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Tertiary-Recent
62.	<i>Bathysiphon</i> sp. ...	...	...	...	f	r	...	...	...	...	...	...	...	...	...	...	...	do.
63.	<i>Cornuspira involvens</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Eocene-Recent
64.	<i>Quinqueloculina seminulum</i>	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
65.	<i>Q. vulgaris</i> ...	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
66.	<i>Q. venusta</i> ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
67.	<i>Cyclammmina incisa</i> ...	...	r	...	...	...	...	...	...	...	...	...	...	...	...	...	...	Eocene-Miocene
68.	<i>Spiroplectammina</i> sp. ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
69.	? <i>Gaudryina subquadrata</i>	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

## SUPERFAMILY SPIRILLINOIDEA.

## FAMILY NODOSARIIDAE.

Genus **LENTICULINA** Lamarck, 1804.**Lenticulina** sp.Plate I, figs. 1 *a*, *b*.

The unique specimen figured represents a form near *L. (Robulus) simplex* (d'Orbigny), described from the Miocene of the Vienna Basin, but has more chambers and the robuline slit is absent.

Subgenus **ROBULUS** Montfort, 1808.**Lenticulina (Robulus) warmani** (Barbat and von Estorff).Plate I, figs. 2 *a*, *b*.

*Robulus nikobarensis* (Schwager), var. *warmani* Barbat and von Estorff, 1933, p. 168, pl. xxiii, figs. 12 *a*, *b*.

*R. warmani* B. & v. E. : Cushman and Hobson, 1935, p. 56, pl. viii, figs. 8 *a*, *b*.

This species, described from the Lower Miocene of California, is represented by a number of typical examples

**Lenticulina (Robulus) gibba** (d'Orbigny).

*Cristellaria gibba* d'Orbigny, 1826, p. 292, No. 17; 1839, p. 63, pl. vii, figs. 20, 21; Cushman, 1923, p. 105, pl. xxv, fig. 4.

This species was originally described as a Recent form from the West Indies and there are numerous records as a fossil from Cretaceous and Tertiary deposits. The King's Park examples agree with specimens I have from off the Island of St. Thomas, in the West Indies.

Genus **MARGINULINA** d'Orbigny, 1826.**Marginulina** sp.

Plate I, fig. 3.

The figure represents a species which I have been unable to identify. The apertural end of the test is missing but immature examples show that the aperture is radiate and slightly projecting at the peripheral angle and that the apertural face is broadly rounded.

Chapman (1917 p. 29, pl. viii, figs. 73, 74) has figured, under the names of *Cristellaria gladius* and *C. acutauricularis*, what appears to be the present species, fig. 73 representing the adult form and fig. 74 an immature specimen. His records were from the Upper Cretaceous of Gingin, W.A.

**Marginulina gladius** (Philippi).

Plate I, fig. 5.

*Marginulina gladius* Philippi, 1843, p. 40, pl. i, fig. 37.

*Cristellaria gladius* (Phil.) : Hantken, 1876, p. 51, pl. v, fig. 12. Nuttall, 1928, p. 89, pl. v, figs. 11, 18.

I have been unable to see Philippi's work in which this species was described. Except that they are shorter, the King's Park specimens agree in essentials with Hantken's figure of this species from the Lower Oligocene of Hungary. A comparison made of a large series of specimens from beds at Kiscell, Hungary, of the same age as those studied by Hantken, shows



the amount of sutural limbation to vary greatly, as in the King's Park examples, the sutures being smooth in some specimens, while, in the best developed examples they are heavily limbate and raised.

The elongate compressed *Marginulina*, with limbate or beaded sutures, are common in the Eocene and Oligocene.

### ***Marginulina subbullata* Hantken.**

Plate I, fig. 6.

*Marginulina subbullata* Hantken, 1876, p. 39, pl. iv, figs. 9, 10; pl. v, fig. 9. Nuttall, 1935, p. 125, pl. xiv, fig. 16.

The figured specimen agrees fairly well with the shorter, apparently megalospheric, examples I have of Hantken's species from the Lower Oligocene of Hungary. There is a very typical specimen in the Commonwealth Palaeontological Collection at Canberra from Claremont Bore No 1, 750-850 feet. This form appears to grade into *M. bullata* Reuss, a Cretaceous species, and *M. pachygaster* Gümbel, from the Eocene.

### ***Marginulina* sp.**

There are numerous broken examples of a species of *Marginulina* resembling *M. costata* (Batsch) in form, but with about twenty-four costae instead of the usual twelve to fourteen found in Batsch's species.

Genus **VAGINULINA** d'Orbigny, 1826.

### ***Vaginulina subplumoides*, sp. nov.**

Plate I, fig. 7.

Test much compressed, faces parallel, initial end pointed and with a small spine, dorsal margin almost straight, ventral margin at first curved outwards, then curved backwards towards the apertural end; chambers numerous, long and narrow; sutures distinct, but largely obscured by the ornament of longitudinal costae, which are not continuous throughout the length of the shell; aperture at the dorsal angle, radiate. Length up to 1mm.; width, up to 0.4 mm.

Holotype from King's Park Bore No. 2, 385 feet.

Five examples were found. This is an interesting species belonging to the group of *Vaginulinae* with intermittent, longitudinal costae. The group is generally characteristic of Mesozoic deposits, the only Tertiary species with which I am acquainted being *V. plumoides* Plummer, from the Eocene (Midway) of Texas, U.S.A. The present species differs from *V. plumoides*, an example of which I have through the kindness of Mrs. Plummer, in its broader outline and differently shaped early portion. *V. intumescens* Reuss, a Lower Cretaceous species, is also somewhat similar, but has fewer and wider chambers.

### ***Vaginulina* sp.**

Plate I, fig. 4.

The figure represents a unique example, 0.45 mm. in length, of a species of *Vaginulina*. It bears some resemblance to the Recent species, *V. patens* Brady, which occurs on the east coast of Australia and off the Philippines, but has a narrower test, without the initial spine of Brady's species.

Genus **DENTALINA** d'Orbigny, 1826.

**Dentalina colei** Cushman and Dusenbury.

Plate I, fig. 8.

*Vaginulina legumen* (Linné), var. *elegans* Cole (non *V. elegans* d'Orbigny), 1927, p. 21, pl. iii, figs. 10-11.

*Dentalina colei* Cushman and Dusenbury, 1934, p. 54, pl. vii, figs. 10-12.

Examples are fairly common and typical. In describing this species, Cushman and Dusenbury point out that the true *V. elegans* has a compressed test, with strongly elevated sutures, and was described from Recent material. The Eocene form to which this name has been assigned has its sutures flush with the surface and is compressed only in the first few chambers. The types of *Dentalina colei* were from the Upper Eocene (Poway conglomerate) of California. Cole's specimens were from the Middle Eocene (Guayabal) of Mexico.

**Dentalina consobrina** d'Orbigny.

*Dentalina consobrina* d'Orbigny, 1846, p. 46, pl. ii, figs. 1-3.

*Nodosaria* (*Dentalina*) *consobrina* (d'Orb.): Chapman and Parr, 1926, p. 381, pl. xviii, fig. 33.

The typical form of this species is represented by a number of broken examples. With these are others with much longer chambers. The latter are similar to the specimens referred to *D. consobrina* and figured by Cushman and G. D. Hanna (1927, p. 214, pl. xiii, figs. 12, 13) from the Eocene of California.

**Dentalina soluta** Reuss.

*Dentalina soluta* Reuss, 1851, p. 60, pl. iii, figs. 4 a, b.

*Nodosaria* (*Dentalina*) *soluta* (Rss.): Chapman and Parr, 1926, p. 383, pl. xix, fig. 40.

One two-chambered specimen and a three-chambered fragment are referred to this species, which was described from the Oligocene of Germany. Cushman (1935, p. 21, pl. viii, figs. 15, 16) has figured similar specimens as *Dentalina* sp. ? from the Upper Eocene of U.S.A.

**Dentalina fissicostata** Gumbel.

*Dentalina fissicostata* Gumbel, 1870, p. 626, pl. i fig. 46.

*Nodosaria fissicostata* (Gumbel): Cushman, 1935, p. 22, pl. v, figs. 8, 9.

Recognizable fragments of this species occur. The types were from the Eocene of Germany and records subsequently include the Upper Eocene of South-eastern United States (Cushman) and the Miocene of Victoria (Chapman and Parr).

**Dentalina spinulosa** (Montagu).

Plate I, fig. 9.

*Nautilus spinulosa* Montagu, 1808, p. 86, pl. xix, fig. 5.

*Dentalina spinulosa* (Mont.): Sherborn and Chapman, 1886, p. 751, pl. xv, fig. 13.

*Nodosaria spinulosa* (Mont.): Plummer, 1926, p. 84, pl. iv, figs. 19 a-c.

There are several fragments bearing the characteristic ornament. This species is common in the Eocene (London Clay) of Piccadilly, England, and in the Eocene (Midway) of Texas, U.S.A. Mrs. Plummer (loc. cit.) notes its occurrence in the Upper Cretaceous of Texas.



Genus **NODOSARIA** Lamarck, 1812.

**Nodosaria** sp. aff. *raphanistrum* (Linné).

Single chambers, apparently of this species, occur fairly frequently. They measure up to 1 mm. in length, with a similar diameter, and are ornamented with twelve heavy costae, the outside edge of which is flat.

**Nodosaria longiscata** d'Orbigny.

*Nodosaria longiscata* d'Orbigny, 1846, p. 32, pl. i, figs. 10-12. Chapman and Parr, 1926, p. 379, pl. xviii, fig. 23.

Fragments are fairly common. The examples represent a more robust form of this species than is usually met with and the chambers are proportionately shorter. Topotype examples from the Miocene of the Vienna Basin show, however, that this form occurs with the slenderer specimens at the type locality. The range of *N. longiscata* is from Eocene to Pliocene.

**Nodosaria radicula** (Linné).

Plate I, fig. 10.

*Nautilus radicula* Linné, 1767, p. 1164; 1788, p. 3373, No. 18.

*Nodosaria radicula* (Lin): Plummer, 1926, p. 77, pl. iv, figs. 9 *a*, *b*.

Typical examples occur. The figured specimen differs from the others in having the penultimate chamber smaller than the adjoining chambers.

Genus **PSEUDOGLANDULINA** Cushman, 1929.

**Pseudoglandulina clarkei**, sp. nov.

Plate I, fig. 11.

Test ovate, longer than broad, the apertural half the wider, circular in transverse section; chambers few, overlapping, indistinct; initial end bluntly rounded; aperture radiate and projecting; wall smooth.

Length up to 1 mm.; diameter to 0.7 mm.

Holotype from King's Park Bore No. 2, 606 feet.

This species is somewhat similar to many of the figures given of *Glandulina laevigata* (d'Orb.) by authors. In the microspheric form of *G. laevigata*, the early chambers are arranged as in *Pyrulina*. One microspheric example of the present species was found and this shows that the initial chambers are as in *Marginulina*. The species is accordingly referred to *Pseudoglandulina*.

The species is named in honour of Professor E. de C. Clarke.

Genus **FRONDICULARIA** Defrance, 1824.

**Fron dicularia mucronata** Reuss.

Plate I, fig. 12.

*Fron dicularia mucronata* Reuss, 1845, p. 31, pl. xiii, figs. 43, 44; 1874, p. 96, pl. xxi, figs. 14-16.

There is one example which agrees with figures 15 and 16 of Reuss's 1874 paper. The species was described from the Upper Cretaceous of Bohemia. Mrs. H. J. Plummer (1926, p. 115, pl. v., fig. 3) has recorded a very similar species under the name of the later-described *F. goldfussi* Reuss from the Lower Eocene (Midway) of Texas, U.S.A.

(?) **Frondicularia** sp.

There is one broken example of a frondicularian form with the characteristic ornament of the Upper Cretaceous species, *Flabellina reticulata* Reuss. The early portion of the test is broken off, but, as the shell does not flare as in *F. reticulata*, it is probable that the species is not that described by Reuss.

Genus **LAGENA** Walker and Jacob, 1798.

**Lagena marginata** (Walker and Boys).

*Serpula (Lagena) marginata* Walker and Boys, 1784, p. 2, pl. i, fig. 7.

There is one specimen with a moderately-compressed pyriform test and a subacute, narrow, marginal keel. This is the typical form of the species.

**Lagena luciae**, sp. nov.

Plate I, fig. 13.

Test globose, a little longer than broad; base bluntly pointed, apertural end produced and ornamented with a few weak spiral costae, body of test ornamented with five evenly-spaced carinae, each of which is regularly tubulated, with the tubules directed towards the base of the shell; wall translucent. Length up to 0.19 mm.

Holotype from King's Park Bore No. 2, 555 feet.

This minute species occurs in several of the samples. It is named in honour of Mrs. N. J. Hanrahan, formerly Lucy F. V. Hosking.

**Lagena acuticosta** Reuss.

*Lagena acuticosta* Reuss, 1862, p. 305, pl. i, fig. 4; Cushman and Ponton, 1932, p. 59, pl. vii, figs. 20 a, b.

Records of this species are from Cretaceous to Recent. Many of the King's Park examples are proportionately a little longer than in the form as figured by Reuss, but are otherwise typical.

**Lagena sulcata** (Walker and Jacob).

*Serpula (Lagena) sulcata* Walker and Jacob, 1798, p. 634, pl. xiv, fig. 5.

*Lagena sulcata* (W. & J.): Brady, 1884, p. 462, pl. lvii, figs. 23, 26, 33, 34.

Small specimens occur, with weaker costae than usual.

**Lagena perthensis**, sp. nov.

Plate I, fig. 14.

Test somewhat pyriform, about one and a half times as long as broad, circular in cross section, base bluntly pointed, apertural end produced, with a short neck; wall of the test covered with very numerous fine longitudinal costae which are connected by delicate cross bars; the apertural end ornamented with small, shallow rounded pits. Length up to 0.43 mm.

Holotype from King's Park Bore No. 2, 430 feet.

I do not know of any described species with which this could be compared. It has a distinctive glistening appearance, due to the play of light on the very delicate reticulate ornament.



**Lagena hexagona** (Williamson).

*Entosolenia squamosa* (Montagu), var. *hexagona* Williamson, 1848, p. 20, pl. ii, fig. 23; 1858, p. 13, pl. i, fig. 32.

*Lagena hexagona* (Will.): Cushman, 1923, p. 24, pl. iv, fig. 6.

Typical examples occur.

**Lagena terrilli**, sp. nov.

Plate I, fig. 15 *a, b*.

Test small, nearly circular in outline, compressed, slightly inflated in the central portion of each face, peripheral margin with two strong encircling keels which are separated by a shallow groove; the chamber faces ornamented with minute pits in more or less concentric rows; aperture an oval fissure at the end of a short broad neck. Length up to 0.36 mm.

Holotype from King's Park Bore No. 2, 430 feet.

This species is fairly common in the samples. It resembles the Recent species, *L. clathrata* Brady, in outline and apertural characters, but differs from that species in being bicarinate and with the surface pitted instead of costate.

The name is given in honour of Mr. S. E. Terrill.

**Lagena orbignyana** (Seguenza).

*Fissurina orbignyana* Seguenza, 1862, p. 66, pl. ii, figs. 24, 26.

*Lagena orbignyana* (Seg.): Brady, 1884, p. 484, pl. lix, figs. 1, 18, 24-26.

Cushman, 1923, p. 40.

The specimens are similar to Brady's fig. 25, but are more inflated, so are similar to the form of *L. orbignyana* which is common in the Lower Miocene of Victoria.

**FAMILY POLYMORPHINIDAE.**

Genus **GUTTULINA** d'Orbigny, 1826.

**Guttulina irregularis** (d'Orbigny).

Plate II, figs. 1 *a, b*.

*Globulina irregularis* d'Orbigny, 1846, p. 226, pl. xiii, figs. 9, 10.

*Guttulina irregularis* (d'Orb.): Cushman and Ozawa, 1930, p. 25, pl. iii, figs. 4, 5; pl. vii, figs. 1, 2.

Typical examples, measuring up to 1.2 mm. in length occur. Cushman and Ozawa's earliest record of this species is from the Eocene.

Genus **GLOBULINA** d'Orbigny, 1826.

**Globulina gibba** d'Orbigny.

*Globulina gibba* d'Orbigny, 1826, p. 266, No. 10; Modèles No. 63.

Cushman and Ozawa, 1930, p. 60, pl. xvi, figs. 1-4.

Small examples are common. The geological range of this species is from Eocene to Recent.

**Globulina rotundata** (Bornemann).Plate II, figs. 2 *a*, *b*.*Guttulina rotundata* Bornemann, 1855, p. 346, pl. xviii, fig. 3.*Globulina rotundata* (Born.): Cushman and Ozawa, 1930, p. 86, pl. xxi, figs. 3, 4. Cushman, 1935, p. 27, pl. ix, fig. 24 *a c*.

This species was described from the Oligocene of Germany and its geological range extends from Eocene to Recent.

**FAMILY BULIMINIDAE.**Genus **BULIMINELLA** Cushman, 1911.**Buliminella westraliensis**, sp. nov.

Plate II, figs. 3, 4.

Test elongate, subcylindrical, more or less twisted in contour, initial end blunt, apertural end rounded; chambers numerous, long and narrow, added obliquely and arranged in a spiral series of about two and a half coils in the adult; sutures distinct, wall smooth; aperture elongate and narrow, in a semi-circular depression just below the end of the test. Length up to 0.40 mm; diameter to 0.1 mm.

Holotype from King's Park Bore No. 1, 755 feet.

This is one of the most distinctive species in the samples. It is subject to a good deal of variation, some of the shorter, apparently juvenile specimens being close to *B. elegantissima* (d'Orb). Generally, however, the examples are like the holotype, when the form of the test and the arrangement of the chambers are intermediate between d'Orbigny's species and *Buliminoides williamsonianus* (Brady).

Genus **ROBERTINA** d'Orbigny, 1846.**Robertina** sp.

Plate II, fig. 5.

This genus is represented by a single example of a form near *R. californica*, a species recently described by Cushman and Parker (1936, p. 97, pl. xvi, figs. 14 *a*, *b*.) from the Pliocene of California. The specimen is apparently a little flattened and the apertural side is obscured by adherent sand grains, hence a closer determination is not possible. The occurrence of this genus in the King's Park bores is of interest as it is not known to occur earlier than the Eocene. While it has not been previously recorded from Australia, it occurs in the Lower Miocene of Victoria.

Genus **ANGULGERINA** Cushman, 1927.**Angulogerina subangularis**, sp. nov.Plate II, figs. 6 *a*, *b*.

Test elongate, about four times as long as broad, sub-triangular in transverse section, with blunt angles, early portion of the test rapidly enlarging and often almost circular in section, the triangular character more pronounced in the later portion of the test, the sides of which are almost parallel; chambers numerous, distinct, slightly inflated, at first regularly



triserial, then loosely triserial and gradually increasing in height; sutures distinct, slightly depressed; wall smooth, finely perforate; aperture circular, terminal, at the end of a short neck. Length up to 0.35 mm.; diameter to 0.09 mm.

Holotype from King's Park Bore No. 1, 770 feet.

This is a common form in the bore samples. It resembles *A vicksburgensis*, described by Cushman (1935a, p. 33, pl. v, figs. 3, 4) from the Lower Oligocene (Byram Marl) of U.S.A. *A. subangularis* is proportionately longer, with more chambers, a longer, regularly-triserial series, and it does not terminate in the distinct neck with phialine lip of Cushman's species.

*Uvigerina canariensis* d'Orb., var *australis* Heron-Allen and Earland, from the Lower Miocene of Batesford, Victoria, is another species belonging to the same group.

#### FAMILY CASSIDULINIDAE.

Genus **CASSIDULINA** d'Orbigny, 1826.

**Cassidulina** sp.

Plate II, fig. 7.

This genus is represented by a single specimen of a form somewhat similar to *C. subglobosa* Brady, but with more numerous chambers.

#### FAMILY HETEROHELICIDAE.

Genus **BOLIVINOPSIS** Yakovlev, 1891.

**Bolivinopsis crespinae**, sp. nov.

Plate III, figs. 11 *a*, *b*.

Test minute, much compressed, about twice as long as wide, initial end rounded, apertural end bluntly pointed, early portion planispirally coiled and forming the widest and thickest part of the test, later portion biserial and with the sides almost parallel; adult chambers numbering four to six, about as high as wide; sutures very distinct, in the biserial portion sharply reflexed, not depressed; wall smooth and polished, calcareous, finely perforate. Length up to 0.2 mm.; width to 0.1 mm.

Holotype from King's Park Bore No. 2, 728 feet.

This is one of the smallest foraminifera occurring in the samples. It is fairly common in Bore No. 2, at 728 feet. No previously-described species closely resembles it. It is named in honour of Miss Irene Crespin, B.A., the Commonwealth Palaeontologist.

The genus *Bolivinopsis*, or as it is better known, *Spiroplectoides*, is most usually found in the Upper Cretaceous, but there are two Eocene species known and a Recent record of *B. rosula* (Ehrenberg) by Heron-Allen and Earland from the vicinity of the Falkland Islands.

**Bolivinopsis eocenica** (Cushman and Barksdale).

*Spiroplectoides eocenica* Cushman and Barksdale, 1930, p. 66, pl. xii, figs. 5 *a*, *b*. Cushman, 1934, p. 43, pl. vi, figs. 28 *a*, *b*.

There are two specimens from Bore No. 2, 728 feet, which seem to be identical with this species, the types of which were from the Eocene of California. This has very low chambers in the biserial portion and the sutures, while distinct, are not thickened and reflexed like those in *B. crespinae*, which occurs in the same sample.

Genus **GÜMBELINA** Egger, 1899.

**Gümbelina venezuelana** Nuttall, var. **rugosa**, var. nov.

Plate II, figs. 8 *a*, *b*.

Nuttall (1935, p. 126, pl. xv, figs. 2-4) described *G. venezuelana* as follows:—Test small, compressed, somewhat flattened, short; tapered to an acute initial end. Border rounded, lobate. Chambers inflated, smooth, separated by narrow depressed sutures. Aperture an oval, arched opening, extending from the base of the last chamber for about one-third of the distance towards the periphery. The width of the aperture is less than the length. Average length 0.4 mm., width 0.4 mm. The types were from the Upper Eocene of Venezuela.

The King's Park specimens agree in form, arrangement of chambers and apertural characters with Nuttall's specimens, but the earlier chambers have a papillate surface. The only other *Gumbelina* with such a surface appears to be *G. wilcoxensis*, described by Cushman and Ponton (1932, p. 66, pl. viii, figs. 16, 17) from the Upper Eocene of Alabama. This is a short broad form with a low aperture.

Length of variety, 0.25 mm.; width, 0.2 mm.

Holotype of variety from King's Park Bore No. 1, 770 feet.

#### FAMILY ROTALIIDAE.

Genus **PATELLINA** Williamson, 1858.

**Patellina** sp. aff. **corrugata** Williamson.

There is one small example measuring 0.21 mm. in diameter. The chambers are more finely subdivided than in *P. corrugata*, but not so finely as in *P. advena* Cushman. The specimen appears to most nearly resemble *P. corrugata*.

Genus **DISCORBIS** Lemareck, 1804.

**Discorbis assulatus** Cushman.

Plate II, figs. 9 *a-c*.

*Discorbis assulata* Cushman, 1933, p. 15, pl. ii, figs. 2 *a-c*. 1935, p. 44, pl. xvii, figs. 1, 2.

This species was described from the Upper Eocene (Ocala limestone) of Georgia, U.S.A. The King's Park specimens are typical, except that they show no tendency to a lobulate periphery.

Genus **HERONALLENIA** Chapman and Parr, 1931.

**Heronallenia pusilla**, sp. nov.

Plate II, figs. 11 *a-c*.

Test very small and almost flat, nearly circular in outline, consisting of four crescentic chambers; chamber wall smooth; sutures comparatively broad, evenly recurved on the dorsal side, on the ventral side strongly reflexed; aperture an elongate, arched slit extending from the spiral suture half-way across the ventral face of the last-formed chamber towards the periphery; wall around the aperture radially ribbed. Maximum diameter, 0.23 mm.

Holotype from King's Park Bore No. 2, 728 feet.



This species is represented by a single example, but the form is so distinct as to justify its being described as new. The genus does not appear to have been previously recorded from beds older than the Oligocene.

Genus **VALVULINERIA** Cushman, 1926.

**Valvulineria sculpturata** Cushman.

Plate II, figs. 10 *a-c*.

*Valvulineria sculpturata* Cushman, 1935 a, p. 37, pl. v, figs. 10 *a-c*.

This is one of the most interesting species met with. It was described by Cushman from the Lower Oligocene of Mississippi, U.S.A., and is here represented by one typical example.

Genus **CERATOBULIMINA** Toula, 1920.

**Ceratobulimina westraliensis**, sp. nov.

Plate II, figs. 12 *a-c*.

Test slightly longer than broad, compressed, umbilicate on the ventral side; periphery rounded; chambers numbering seven to eight in the last-formed whorl; sutures thickened and sometimes limbate and raised in the early portion of the test, depressed in the later portion of the shell; wall thick and polished; aperture a slit at the base of the inner margin of the last-formed chamber, septal face of chamber with a median umbilical notch and dent of varying width. Length up to 0.5 mm.; width to 0.4 mm.; thickness to 0.25 mm.

Holotype from King's Park Bore No. 2, 230 feet.

This is one of the common species in the samples. *C. perplexa* (Plummer), from the Eocene (Midway) of Texas, U.S.A., is fairly closely related, but has only six chambers to the adult whorl and a smaller and more rounded umbilical depression than the present species. *C. westraliensis* also has generally a much larger umbilical notch than *C. perplexa*, although it is variable in this respect.

Genus **GYROIDINA** d'Orbigny, 1826.

**Gyroidina soldanii** d'Orbigny.

Plate II, figs. 13 *a, b*.

*Gyroidina soldanii* d'Orbigny, 1826, p. 278, No. 5, Modèles No. 36.

Cushman, 1931, p. 38, pl. viii, figs. 3-8.

There are numerous specimens resembling the Recent example figured by Cushman (loc. cit., figs. 3 *a-c*) as a young form of *G. soldanii*, and others intermediate between this and the normal, adult form of this species. The typical adult form is in the Commonwealth Palaeontological Collection at Canberra from the Claremont No. 1 Bore at 300-350 feet.

**Gyroidina soldanii** d'Orbigny, var. **octocamerata** Cushman and G. D. Hanna.

Plate II, figs. 14 *a-c*.

*Gyroidina soldanii* d'Orb., var. *octocamerata* Cushman and G. D. Hanna, 1927, p. 223, pl. xiv, figs. 16-18. Cushman, 1935, p. 45, pl. xviii, figs. 4 *a-c*.

The specimens agree well with Cushman's figure of this form from the Upper Eocene (Ocala limestone) of Alabama, U.S.A. Cushman notes that

it also occurs in the Claiborne group as well as in the equivalent Eocene of Mexico and California. The types were from the Eocene of California.

The features distinguishing this from the well-known *G. soldanii* are its smaller size, (maximum diameter 0.50 mm.) and the eight chambers in the adult whorl. The Perth specimens attain a diameter of 0.41 mm. and are thinner-shelled than is usual in *G. soldanii*.

Genus **PULVINULINELLA** Cushman, 1926.

**Pulvinulinella obtusa** (Burrows and Holland), var. **westraliensis**, var. nov.

Plate III, figs. 1 *a-c*.

*Pulvinulinella exigua* (Brady), var. *obtusa* Cushman and Ponton, (non *Pulvinulina exigua*, var. *obtusa* Burrows and Holland), 1932, p. 71, pl. ix, figs. 9 *a-c*.

Test small, biconvex, the dorsal side less convex than the ventral, peripheral margin subacute and sometimes slightly lobulated; chambers few, distinct, usually six in the last-formed whorl; sutures distinct, on the dorsal side very oblique, almost straight, ventrally nearly radial and a little depressed, beginning from a small filled umbilicus; wall smooth, comparatively thick; aperture on the ventral side of the peripheral face, elongate, nearly parallel to the plane of coiling. Diameter up to 0.36 mm.; height to 0.25 mm.

Holotype of variety from King's Park Bore No. 2, 728 feet.

This form is common in the samples. It is closely related to the form described by Burrows and Holland (1897, p. 49, pl. ii, fig. 25) from the Lower Eocene of the Isle of Thanet, under the name of *Pulvinulina exigua* Brady, var. *obtusa*. My friend, Mr. F. Chapman, has kindly supplied me with a number of examples of var. *obtusa* from the type locality, Pegwell Bay, and these show it to belong to the genus *Pulvinulinella*. While it is probable that *Pulvinulina exigua* Brady should be placed in the same genus, the differences between the two forms, one described from Recent seas, in which it is usually found in very deep water, and the other known only from the Eocene, in deposits laid down in moderately shallow water, are, to the writer's mind, conclusive evidence that they are specifically distinct and they are here dealt with accordingly. The Eocene specimens figured by various writers as *P. exigua* do not show a close resemblance to the figures given by Brady (1884, pl. ciii, figs. 13, 14), although they do to *P. obtusa*. Burrows and Holland state that in *P. exigua*, the acute lobulated periphery is remarkably constant, while the obtuse periphery and more compact habit are no less constant characters in the var. *obtusa*.

The Western Australian form differs from the examples of *P. obtusa* from Pegwell Bay in having the dorsal side only slightly convex, while the ventral side is strongly so. The margin is subacute, compared with the rounded margin of *P. obtusa*. In other respects they are similar.

A form closely related to the present one is that described by Chapman, Parr, and Collins (1934, p. 565, pl. ix, figs. 19 *a-c*) as ? *Pulvinulinella tenui-marginata*, from the Lower Miocene of Victoria. This has a thinner, sharply-margined test and is possibly derived from the Western Australian form.



Genus **EPISTOMINA** Terquem, 1883.

**Epistomina elegans** (d'Orbigny).

*Rotalia (Turbinulina) elegans* d'Orbigny, 1826, p. 276, No. 54.

*Epistomina elegans* (d'Orb): Cushman, 1927, p. 182, pls. xxxi, xxxii.

Small, but otherwise typical examples occur.

Genus **SIPHONINA** Reuss, 1849.

**Siphonina** sp.

Plate III, fig. 2.

One small, broken example of a species of *Siphonina*, which could not be determined, was met with.

Genus **ANOMALINA** d'Orbigny, 1826.

**Anomalina perthensis**, sp. nov.

Plate III, fig. 3 *a-c*.

Test of about two and a half coils, almost bilaterally symmetrical with broadly rounded periphery, the dorsal side slightly evolute and with all of the whorls visible, chambers numerous, up to twelve in the last-formed whorl, chamber wall smooth on dorsal side, coarsely perforate on ventral side; sutures broad and sometimes limbate and raised, gently recurved, the amount of curvature being greater on the dorsal side than on the ventral; aperture a narrow curved opening at the base of the last chamber. Diameter up to 0.37 mm.; thickness to 0.13 mm.

Holotype from King's Park Bore No. 2, 728 feet.

This species resembles *A. bilateralis* Cushman, from the Lower Oligocene of U.S.A., but a comparison with examples of Cushman's species shows that the two are distinct. *A. perthensis* is distinguishable by its much smaller size (one-third of that of *A. bilateralis*), thicker test, which is quite different in edge view, and the invariably smooth wall of the chambers on the dorsal side.

**Anomalina westraliensis**, sp. nov.

Plate III, figs. 4 *a-c*.

Test plano-convex, consisting of about one and a half whorls, involute on the ventral side, very slightly evolute on the dorsal; ventral side flattened, sometimes slightly concave, dorsal side broadly convex; periphery rounded in young specimens, becoming sub-acute in the adult, lobulated in the later part of the test; chambers comparatively few, 8 in the last-formed whorl; sutures recurved, limbate except in the last two or three chambers, slightly depressed on the ventral side, on the dorsal side flush, sometimes raised; wall calcareous, very coarsely perforated in the adult; aperture an arched slit at the inner margin of the last chamber. Diameter to 0.7 mm.; thickness to 0.2 mm.

Holotype from King's Park Bore No. 1, 770 feet.

This species shows an interesting development, the early stages being almost bilaterally symmetrical with a rounded peripheral margin, as in the more typical species of *Anomalina*. The plano-convex test and sub-acute margin of the test in the adult are reminiscent of *Cibicides*.

Genus **CIBICIDES** Montfort, 1808.

**Cibicides lobatulus** (Walker and Jacob).

*Nautilus lobatulus* Walker and Jacob, 1798, p. 642, pl. xiv, fig. 36.

*Cibicides lobatulus* (W. & J.): Cushman, 1931, p. 118, pl. xxi, figs. 3 *a-c*; 1935, p. 52, pl. xxii, figs. 4-6.

Typical examples occur. Cushman (1935, op. cit.), in recording this species from the Upper Eocene of the United States, notes it is common in the various members of the earlier Tertiary.

**Cibicides pseudoconvexus**, sp. nov.

Plate III, figs. 5 *a-c*.

Test plano-convex to concavo-convex, the ventral attached side flattened or concave, the dorsal side strongly convex, periphery sub-acute and frequently with a slight keel, particularly in the earlier part of the shell; chambers fairly numerous, 5 in the last-formed whorl, increasing rapidly in size and height as added, all chambers visible from the ventral side, only those of the last-formed whorl visible from the dorsal side; sutures distinct, strongly depressed and radial on the dorsal side, on the ventral side slightly depressed, recurved; wall smooth and finely perforate; aperture at the periphery and extending over and along the inner margin of the chamber on the ventral side. Diameter up to 0.7 mm.; thickness to 0.4 mm.

Holotype from King's Park Bore No. 1, 770 feet.

This species is common in the samples. It is closely related to the Upper Cretaceous *C. convexus* (Reuss), but the chambers increase more rapidly in size, the earlier chambers are keeled, and the shell wall is finely perforate, while that of *C. convexus* is coarsely perforate.

**Cibicides pseudoungerianus** (Cushman).

*Truncatulina ungeriana* Brady (non *Rotalina ungeriana* d'Orbigny), 1884, pl. xciv, figs. 9 *a-c*.

*T. pseudoungeriana* Cushman, 1922, pp. 97, 136, pl. xx, fig. 9.

*Cibicides pseudoungerianus* (Cush): Cushman, 1931, p. 123, pl. xxii, figs. 3-7; 1935, p. 52, pl. xxiii, figs. 1 *a-c*.

There are several fairly typical examples. This species has a geological range of from Eocene to Recent. It was described from the Lower Oligocene of the United States.

**Cibicides umbonifer**, sp. nov.

Plate III, fig. 6 *a-c*.

Test plano-convex, flattened on the ventral face, periphery subacute and limbate; chambers 10 to 12 in the last-formed whorl, those of the earlier whorls usually obscured by the thickening of the surface; sutures distinct in the last-formed whorl, gently recurved on both sides of the test, flush with the surface on the dorsal side, generally depressed on the ventral side; umbilical region filled with a conspicuous plug of clear shell material, which is flush with the chambers; surface on the ventral side distinctly perforate, on the dorsal side smooth and very finely perforate; aperture peripheral extending over to the ventral side of the test, with a slight lip. Diameter up to 0.5 mm.; thickness to 0.2 mm.



Holotype from King's Park Bore No. 2 728 feet.

This species is common in the samples. It is related to *C. pseudoungerianus*, but is proportionately thicker, has limbate sutures on the ventral side, and a larger and flush umbilical boss on the dorsal side. The outside whorl is also narrower than that of *C. pseudoungerianus*.

#### FAMILY CHILOSTOMELLIDAE.

Genus **PULLENIA** Parker and Jones, 1862.

##### ***Pullenia quinqueloba* (Reuss).**

*Nonionina quinqueloba* Reuss, 1851, p. 47, pl. v, fig. 31.

*Pullenia quinqueloba* (Reuss): Plummer, 1926, p. 136, pl. viii, figs. 12 a, b.

Typical examples of this widely-distributed species were met with.

#### FAMILY ORBULINIDAE.

Genus **GLOBIGERINA** d'Orbigny, 1826.

##### ***Globigerina triloba* Reuss.**

*Globigerina triloba* Reuss, 1850, p. 374, pl. xlvii, figs. 11 a-e.

This species was described from the Miocene of the Vienna Basin. The present specimens agree with examples I have from Baden, near Vienna.

##### ***Globigerina inflata* d'Orbigny.**

*Globigerina inflata* d'Orbigny, 1839a, p. 134, pl. ii, figs. 7-9. Brady, 1884, p. 601, pl. lxxix, figs. 8-10. Nuttall, 1935, p. 130.

Small specimens occur. This species, which exists at the present day in every ocean, is stated by Nuttall (loc. cit.) to be common in the Upper and Middle Eocene of Mexico and in the Upper Eocene of Trinidad. Nuttall's record was from the Upper Eocene of Venezuela.

##### ***Globigerina orbiformis* Cole.\***

Plate III, figs. 7 a, c.

*Globigerina orbiformis* Cole, 1927, p. 33, pl. v, fig. 7.

Typical examples occur. Dr. J. A. Cushman has kindly supplied me with specimens of this species from some of Dr. Cole's type material from the Middle Eocene (Guayabal Formation) at Guayabal, Mexico. It appears to be closely related to *G. inflata*, with which it occurs.

Genus **GLOBOROTALIA** Cushman, 1927.

##### ***Globorotalia chapmani*, sp. nov.**

Plate III, figs. 8, 9 a, b.

Test biconvex, oval, the dorsal surface more convex than the ventral, which is umbilicate; periphery lobulated, peripheral margin rounded; chambers comparatively few, not more than five in the last-formed whorl, each

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\*Dr. H. Thalmann has since informed the writer that *G. orbiformis* is identical with the earlier-described *G. mexicana* Cushman (1925, Contr. Cushman Lab., vol. I, p. 6, pl. i, fig. 8), from the Upper and Middle Eocene of East Mexico. This opinion is the result of several years experience in Mexico, during which Dr. Thalmann examined much material from the Guayabal (now known as the Tempoal) Formation.

much larger than its predecessor; sutures depressed, not limbate, gently re-curved on both sides of the test; wall smooth and punctate, with a silvery lustre; aperture an elongate slit with a slight lip, opening at the base of the last-formed chamber into the umbilical depression. Length up to 0.65 mm.

Holotype from King's Park Bore No. 1, 755 feet.

This species belongs to the group of *G. hirsuta* (d'Orbigny) and is perhaps nearest to *G. hirsuta*, which has typically only four chambers to a whorl and with the sutures on the ventral side radial.

#### FAMILY NUMMULITIDAE.

Genus **NONION** Montfort, 1808.

**Nonion novozealandicus** Cushman.

*Nonion novozealandicus* Cushman, 1936, p. 66, pl. xii, figs. a, b.

This species was recently described by Dr. Cushman from the Lower Oligocene of Motutara Point, Kawhia Harbour, New Zealand. In the King's Park bore samples, examples are common. They attain a diameter of 0.5 mm. and a thickness of 0.2 mm., and so are proportionately slightly thinner than the dimensions given by Cushman. Many of the examples I have from the type locality show a similar variation.

#### SUPER-FAMILY AMMODISCOIDEA.

##### FAMILY AMMODISCIDAE.

Genus **AMMODISCUS** Reuss, 1861.

**Ammodiscus** sp. aff. *incertus* (d'Orbigny).

There are two fragments, the larger measuring 1.9 mm. in length and consisting of portion of three whorls, which appear to be d'Orbigny's species.

#### FAMILY RHIZAMMINIDAE.

Genus **BATHYSIPHON** M. Sars, 1872.

**Bathysiphon** sp.

Plate III, fig. 10.

Fragments of a species of *Bathysiphon* are common. They are generally ovate in section, and attain a diameter of 2 mm. The central cavity is about one-third of the diameter. The tube in some specimens is transversely constricted or corrugated and the surface is usually coated with a black film. The wall consists mainly of siliceous sand and a small proportion of broken sponge spicules, with abundant siliceous cement. The species is probably new, but more and better material is needed to decide this.

#### FAMILY OPHTHALMIDIIDAE.

Genus **CORNUSPIRA** Schultze, 1854.

**Cornuspira involvens** (Reuss).

*Operculina involvens* Reuss, 1850, p. 370, pl. xlvi, fig. 2.

*Cornuspira involvens* (Reuss): Cushman, 1929, p. 80, pl. xx, figs. 6, 8.

There is one typical example.



## FAMILY MILIOLIDAE.

Genus **QUINQUELOCULINA** d'Orbigny, 1826.**Quinqueloculina seminulum** (Linné).*Serpula seminulum* Linné, 1767, p. 1264.*Quinqueloculina seminulum* (Linné): Cushman, 1929, p. 24, pl. ii, figs. 1, 2. Cushman and Cahill, 1933, p. 9, pl. ii, figs. 2 a-c.

Small specimens occur. The smooth species of *Quinqueloculina* are difficult to separate without abundant specimens and sections, and identifications based on exterior characters are therefore unsatisfactory. The three species here recorded have been so identified, as I have not been able to obtain good sections. Forms very similar to the present specimens have been identified from the Eocene of the United States as *Q. seminulum* (Stadnichenko, Journ. Pal., vol. i, 1927, p. 226, pl. xxxviii, fig. 28), *Q. yeguaensis* (Weinzierl and Applin, Journ. Pal., vol. iii, 1929, p. 393, pl. xlv, fig. 4) and *Q. laevigata* d'Orb. (Cushman, 1935, p. 11, pl. ii, figs. 13-15).

**Quinqueloculina vulgaris** d'Orbigny.*Quinqueloculina vulgaris* d'Orbigny, 1826, p. 302, No. 33. Cushman, 1929, p. 25, pl. ii, figs. 3 a-c.

There are several small examples, the largest measuring 0.45 mm. in length.

**Quinqueloculina venusta** Karrer.*Quinqueloculina venusta* Karrer, 1868, p. 147, pl. ii, fig. 6.*Miliolina venusta* (Karrer): Brady, 1884, p. 162, pl. v, figs. 5, 7.

There are a few small examples with blunter angles than those figured by Brady.

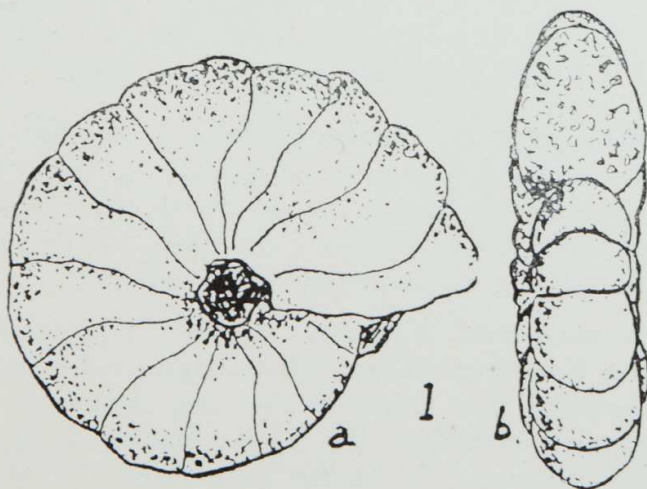
## FAMILY LITUOLIDAE.

Genus **CYCLAMMINA** Brady, 1876.**Cyclammina incisa** (Stache).

Text-fig. 1.

*Haplophragmium incisum* Stache, 1864, p. 165, pl. xxi, fig. 1.*Cyclammina incisa* (Stache): Chapman, 1926, p. 29, pl. ii, fig. 1. Cushman and Barbat, 1932, p. 32, pl. v, figs. 2 a, b.

Test much compressed, umbilicate; chambers eight to ten in the last-formed whorl, somewhat irregular in size; sutures slightly depressed, a



Text-figs. 1 a, b. *Cyclammina incisa* (Stache). Bore No. 1, 530 ft. a, side view; b, peripheral view.  $\times 26$ .

little curved, nearly radial; wall finely arenaceous, rather smoothly finished. Diameter up to 2.1 mm.

This species was described from the Lower Oligocene of Whaingaroa Harbour, New Zealand. It is common in the King's Park bore samples. The largest specimen measures 2 mm. in diameter, but generally they do not exceed 1.2 mm.

#### FAMILY TEXTULARIIDAE.

Genus **SPIROPLECTAMMINA** Cushman, 1927.

**Spiroplectammina** sp.

Plate III, figs. 12 *a*, *b*.

There are several examples of a small species of this genus, but insufficient for specific determination. Megalospheric and microspheric specimens are present. In the former, the coil forms about one-third of the test. The remainder of the test is parallel-sided and consists of about eight chambers with slightly depressed sutures, the height of each chamber being about half the length. The test is sub-rhomboidal in end view; the wall is composed of fine sand grains, with a good deal of cement, resulting in a smoothly-finished surface. The microspheric form begins with a much smaller coil and the test consequently gradually increases in width instead of having the sides parallel as in the megalospheric form. Both forms attain a length of 0.35 mm. and a width of 0.16 mm.

#### FAMILY VERNEUILINIDAE.

Genus **GAUDRYINA** d'Orbigny, 1839.

(?) **Gaudryina subquadrata** Cushman.

*G. subquadrata* was described by Cushman (1933, p. 2, pl. i, figs. 1 *a-c*) from the Upper Eocene of South Carolina. It is a very elongate tapering species, almost rectangular in section, and with a very short triserial portion. The broader faces are distinctly concave. The species attains a length of 1 mm.

The specimens from the King's Park borings are doubtfully referred to this species as the initial end is, in every case, broken off, but in other respects they agree with Cushman's description and figures. The largest specimen is 0.75 mm. long, 0.28 mm. wide, and 0.18 mm. thick.

#### THE AGE OF THE SAMPLES.

The assemblage of foraminifera includes a number of long-ranging species, but with these are associated a number of more restricted forms, or forms closely related to species, mainly North American, with a limited range. The ranges of species previously described will be found in the table showing the distribution of foraminifera in the bores.

*Frondicularia mucronata* is typically Upper Cretaceous, but appears to occur in the Lower Eocene of Texas. *Bolivinosia eocenica*, *Dentalina colei*, and *Gyroidina soldanii*, var. *octocamerata* are American Eocene species. *Discorbis assulatus* is confined to the Upper Eocene of the United States, while *Globigerina orbiformis* is known only from the Middle Eocene of Mexico.



*Vaginulina subplumoides*, sp. nov., is near *V. plumoides*, from the Lower Eocene of Texas. *Gümbelina venezuelana*, a new variety of which is described, is known only from the Upper Eocene of Venezuela. *Pulvinulinella obtusa*, var. *westraliensis*, nov., appears to be present in the Eocene of the United States.

With these is *Valvulineria sculpturata*, a very distinct species, recently described from the Lower Oligocene of the United States. *Angulogerina subangularis*, sp. nov., is closely related to, but more primitive than *A. vicksburgensis*, also confined to the Lower Oligocene of the United States.

On this evidence there can be little doubt that the faunule is definitely of Eocene age. The presence of species identical with or similar to other restricted Upper Eocene forms, with a slight Lower Oligocene element, indicates that the beds are high in the Eocene and they are accordingly considered to be of Upper Eocene age.

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## APPENDIX.

By the courtesy of the Commonwealth Geological Adviser, Dr. W. G. Woolnough, and the Commonwealth Palaeontologist, Miss Irene Crespin, B.A., who have made available the slides of foraminifera in the Commonwealth Palaeontological Collection at Canberra from other borings in the Perth area, the following additional records of the new species described in this paper are given.

*Lagena perthensis*

Zoological Gardens Bore—615ft.

*L. terrilli*

Claremont No. 1 Bore—100-150ft., 250-300ft., 300-350ft., 750-850ft. Zool. Gardens Bore—615ft.

*Buliminella westraliensis*

Claremont No. 1 Bore—92-100ft., 100-150ft., 150-200ft., 200-250ft., 750-850ft. Zool. Gardens Bore—960ft.

*Angulogerina subangularis*

Claremont No. 1 Bore—100-150ft., 150-200ft., 200-250ft., 250-300ft.

*Bolivinopsis crespinae*

Claremont No. 1 Bore—300-350ft.

*Heronallenia pusilla*

Claremont No. 1 Bore—300-350ft., 750-850ft.

*Ceratobulimina westraliensis*

Claremont No. 1 Bore—100-150ft.

*Pulvinulinella obtusa*, var. *westraliensis*

Claremont No. 1 Bore—92-100ft., 150-200ft.

*Anomalina perthensis*

Claremont No. 1 Bore—100-150ft.

*Anomalina westraliensis*

Zool. Gardens Bore—615ft.

*Cibicides pseudoconvexus*

Claremont No. 1 Bore—150-200ft., 250-300ft., 300-350ft.

*C. umbonifer*

Claremont No. 1 Bore—92-100ft., 100-150ft., 150-200ft., 250-300ft., 300-350ft., 750-850ft. Zool. Gardens Bore—217ft., 615ft., 960ft.

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## EXPLANATION OF THE PLATES.

## Plate I.

- Figs. 1 *a, b*. *Lenticulina* sp. Bore No. 1, 120 ft. *a*, side view; *b*, front view.  
× 39.
- „ 2 *a, b*. *L. (Kobulus) warmani* (Barbat and Estorff). Bore No. 2, 230 ft.  
*a*, side view; *b*, front view. × 39.
- „ 3. *Marginulina* sp. Bore No. 2, 230 ft. × 39.
- „ 4. *Vaginulina* sp. Bore No. 2, 385 ft. × 39.
- „ 5. *Marginulina gladius* Philippi. Bore No. 1, 120 ft. × 39.
- „ 6. *M. subbullata* Hantken. Bore No. 1, 120 ft. × 39.
- „ 7. *Vaginulina subplumoides*, sp. nov. Holotype. Bore No. 2, 385 ft.  
× 39.
- „ 8. *Dentalina colei* Cushman and Dusenbury. Bore No. 1, 120 ft.  
× 39.
- „ 9. *D. spinulosa* (Montagu). Bore No. 1, 770 ft. × 39.
- „ 10. *Nodosaria radicola* (Linné). Bore No. 1, 120 ft. × 39.
- „ 11. *Pseudoglandulina clarkei*, sp. nov. Holotype. Bore No. 2, 606 ft.  
× 39.
- „ 12. *Fronicularia mucronata* Reuss. Bore No. 2, 430 ft. × 39.
- „ 13. *Lagena luciae*, sp. nov. Holotype. Bore No. 2, 555 ft. × 78.
- „ 14. *L. perthensis*, sp. nov. Holotype. Bore No. 2, 430 ft. × 78.
- „ 15 *a, b*. *L. terrilli*, sp. nov. Holotype. Bore No. 2, 430 ft. *a*, side view;  
*b*, apertural view. × 39.



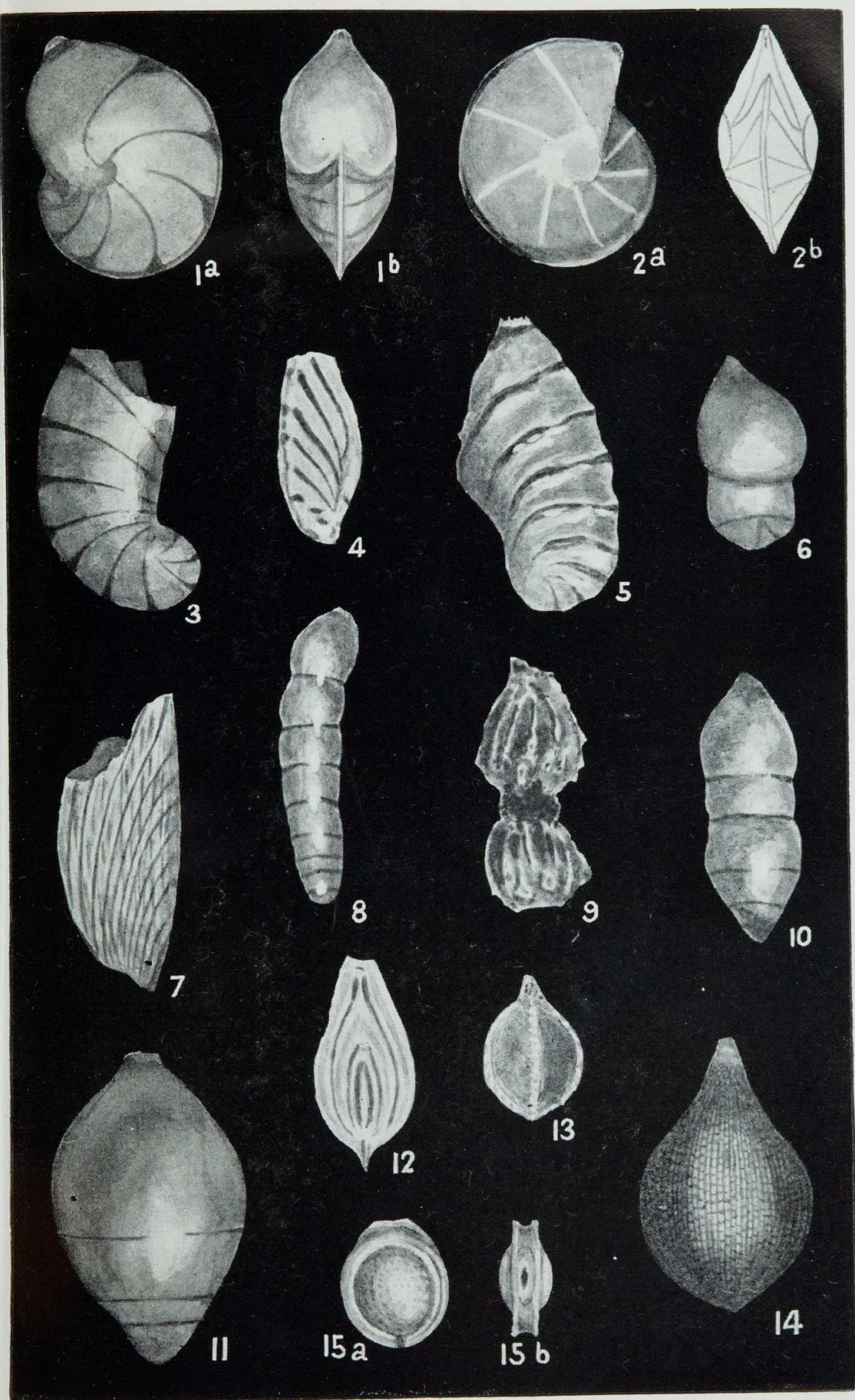


PLATE I.



## Plate II.

- Figs. 1 *a, b.* *Guttulina irregularis* (d'Orbigny). Bore No. 2, 230 ft. *a*, side view; *b*, basal view.  $\times 26$ .
- „ 2 *a, b.* *Globulina rotundata* (Bornemann). Bore No. 1, 120 ft. *a*, side view; *b*, basal view.  $\times 26$ .
- „ 3, 4. *Buliminella westraliensis*, sp. nov. 3, Holotype. Bore No. 1, 755 ft. 4, Bore No. 2, 728 ft. Both  $\times 78$ .
- „ 5. *Robertina* sp. Bore No. 1, 755 ft.  $\times 78$ .
- „ 6 *a, b.* *Angulogerina subangularis*, sp. nov. Holotype. Bore No. 1, 770 ft. *a*, side view; *b*, apertural view.  $\times 78$ .
- „ 7. *Cassidulina* sp. Bore No. 1, 755 ft.  $\times 78$ .
- „ 8 *a, b.* *Gümbelina venezuelana* Nuttall, var. *rugosa*, var. nov. Holotype. Bore No. 1, 770 ft. *a*, side view; *b*, edge view.  $\times 78$ .
- „ 9 *a-c.* *Discorbis assulatus* Cushman. Bore No. 2, 555 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 78$ .
- „ 10 *a-c.* *Valvulineria sculpturata* Cushman. Bore No. 2, 728 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 78$ .
- „ 11 *a-c.* *Heronallenia pusilla*, sp. nov. Holotype. Bore No. 2, 728 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 78$ .
- „ 12 *a-c.* *Ceratobulimina westraliensis*, sp. nov. Holotype. Bore No. 2, 606 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 52$ .
- „ 13 *a, b.* *Gyroidina soldanii* d'Orbigny. Bore No. 2, 230 ft.  $\times 78$ .
- „ 14 *a-c.* *G. soldanii*, var. *octocamerata* Cushman and G. D. Hanna. Bore No. 1, 755 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 78$ .



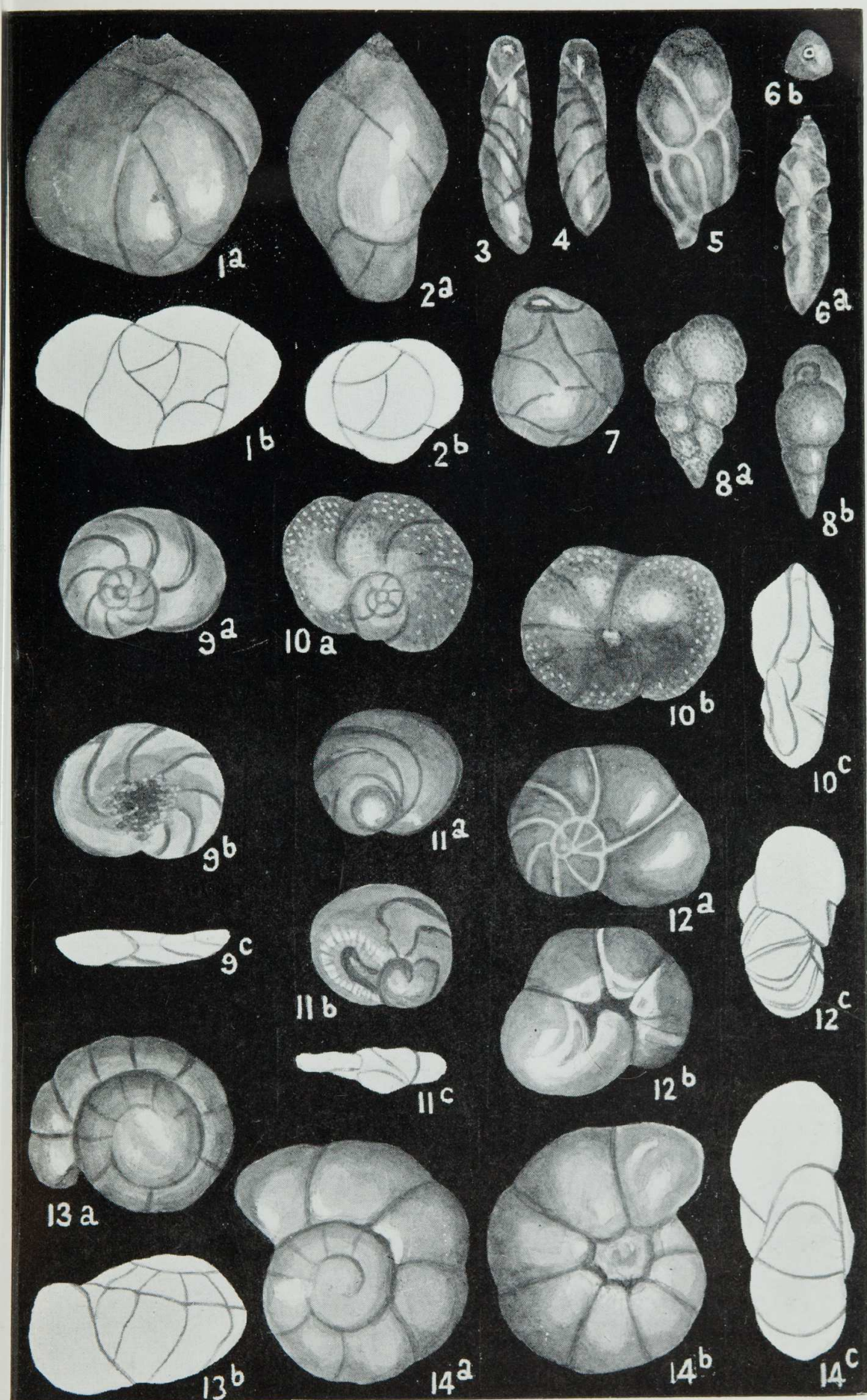


PLATE II.



## Plate III.

- Figs. 1 *a-c. Pulvinulinella obtusa* (Burrows and Holland), var. **westraliensis**, var. nov. Holotype. Bore No. 2, 728 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 78$ .
- „ 2. *Siphonina* sp. Bore No. 1, 492 ft.  $\times 117$ .
- „ 3 *a-c. Anomalina perthensis*, sp. nov. Holotype. Bore No. 2, 728 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 78$ .
- „ 4 *a-c. A. westraliensis*, sp. nov. Holotype. Bore No. 1, 770 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 39$ .
- „ 5 *a-c. Cibicides pseudoconvexus*, sp. nov. Holotype. Bore No. 1, 770 ft. *a*, ventral view; *b*, dorsal view; *c*, edge view.  $\times 39$ .
- „ 6 *a-c. C. umbonifer*, sp. nov. Holotype. Bore No. 2, 728 ft. *a*, ventral view; *b*, dorsal view; *c*, edge view.  $\times 78$ .
- „ 7 *a-c. Globigerina orbiformis* Cole. Bore No. 1, 755 ft. *a*, dorsal view; *b*, ventral view; *c*, edge view.  $\times 78$ .
- „ 8, 9 *a, b. Globorotalia chapmani*, sp. nov. Bore No. 1, 755 ft. 9 *a, b*, Holotype. *a*, ventral view; *b*, edge view. 8. Dorsal view of another specimen. All  $\times 78$ .
- „ 10. *Bathysiphon* sp. Bore No. 1, 563-573 ft.  $\times 13$ .
- „ 11 *a, b. Bolivinopsis crespinae*, sp. nov. Holotype. Bore No. 2, 728 ft. *a*, side view; *b*, edge view.  $\times 117$ .
- „ 12 *a, b. Spiroplectammina* sp. Bore No. 2, 728 ft. *a*, side view; *b*, apertural view.  $\times 78$ .



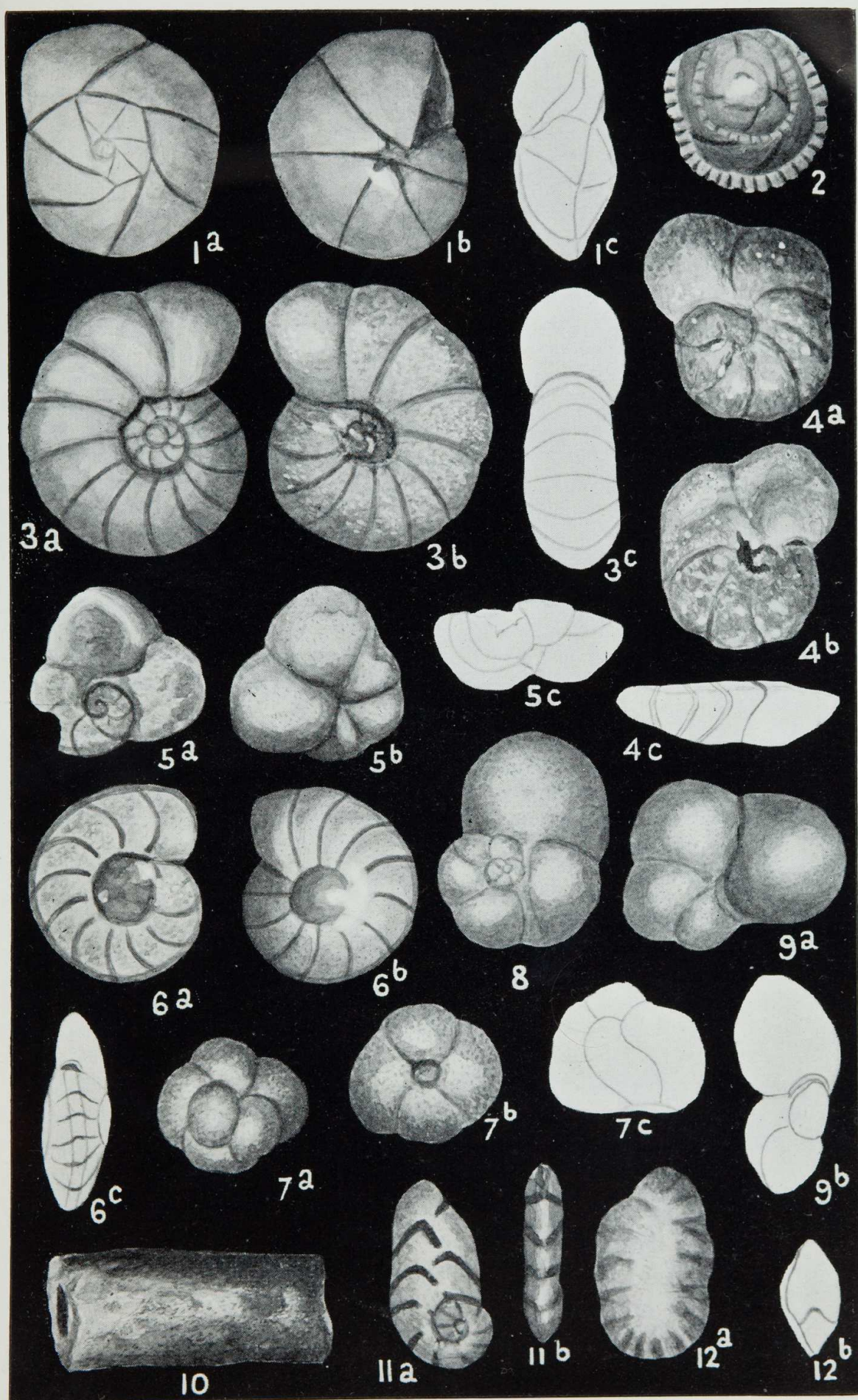


PLATE III.